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Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) – Annex 46

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Annex 46 Scope

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Government non-residential buildings, e.g.:

- **office/administrative buildings,**
- **dormitories/barracks**
- **service buildings**
- **one storey production and**
- **maintenance facilities**

Annex 46 Target Groups

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- Architects, Building, Process and Energy Systems Designers
- Building energy managers
- Contractors and investors
- Decision-makers
- Energy auditors
- Energy Services Companies

Annex 46 Objectives

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- **Provide tools and guidelines to identify energy conservation opportunities in Government and Public buildings**
- **Support decision makers in evaluating the efficiency and acceptance of available energy concepts.**
- **Promote energy- and cost-efficient retrofit measures by providing successful examples.**
- **Find improved ways of using Energy Performance Contracts (EPCs) for Government and Public buildings retrofit measures.**

Annex 46* Has Four Subtasks Addressing

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A. Energy Assessment Protocol (Canada, Denmark, Finland, France, Germany, Poland, Russia, USA)

B. Technology Database (Canada, Denmark, Finland, France, Germany, Italy, Poland, Russia, Slovakia, UK, USA)

C. Best Practice Guidelines for EPCs (Denmark, Finland, Germany, USA)

D. Energy Concept Adviser Toolkit "EnERGo" (Canada, Denmark, Finland, France, Germany, Italy, Poland, Russia, Slovakia, UK, USA)

Subtask A: Develop an energy assessment and analysis methodology/protocol "Energy Assessment Guide for Energy Managers and ESCOs":

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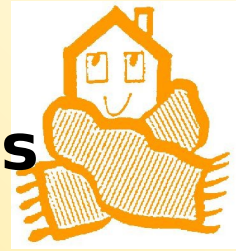

- **Analysis of best practices and procedures of identifying energy conservation opportunities in retrofitted Government buildings**
- **Development of a consensus protocol for conducting energy assessments at Government administrative/office buildings and production and maintenance facilities**

Different Levels of Depths and Breadth of Energy Assessment

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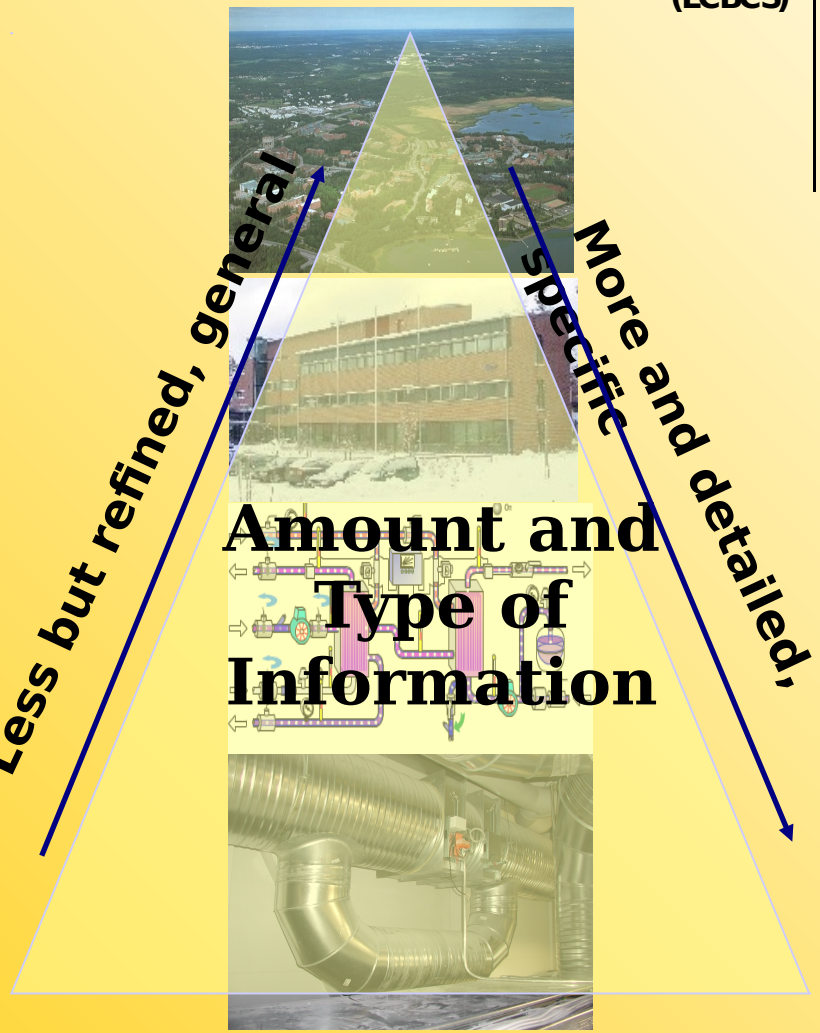
1. Building stock
2. Building
3. System
4. Component



Holistic Approach to Energy Usage and Waste

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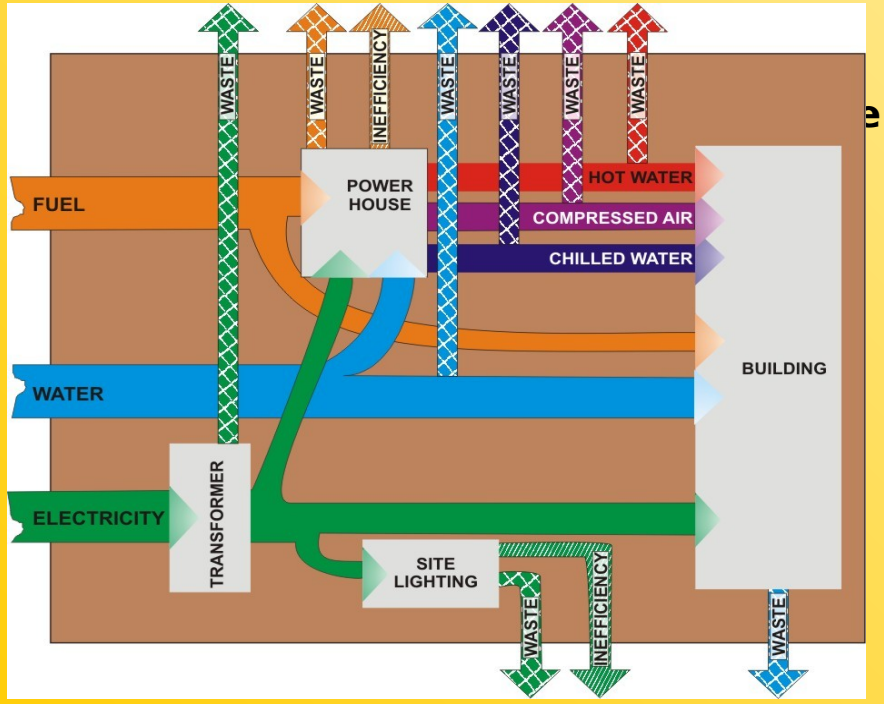
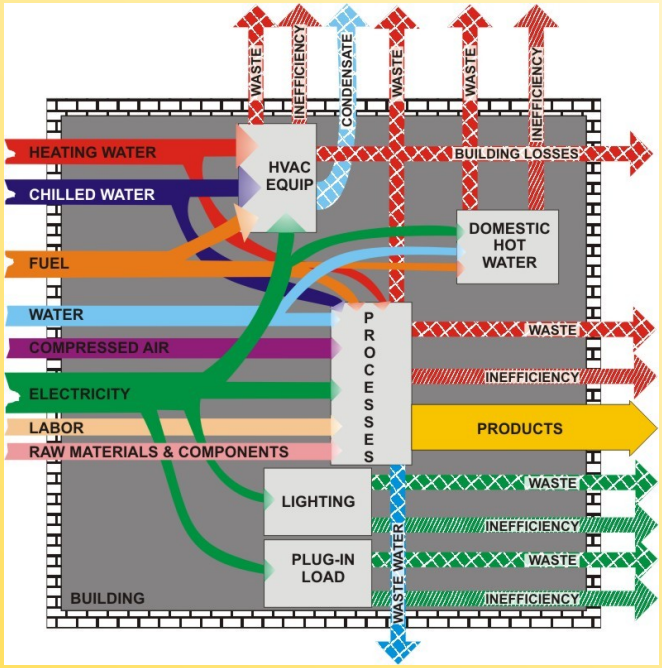
Sankey diagram example showing how energy supplied to the Building Complex (University or Hospital Campus, Army Installation) is used and where it is wasted, e.g.,:

- **In the power house (for a CWS and HWS, and power generation): combustion losses with**



Sankey diagram example for Building energy systems

- **Heating,**
- **Cooling**
- **Ventilation**
- **Compressed Air**
- **Water**
- **Sewage**
- **Process**
- **Lights**
- **Plug-in**



<u>Subtask B</u>: Develop a database of "Energy Saving Technologies and Measures for Government Building Retrofits" with examples of best practices:

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- Document a series of completed and planned best practices of buildings retrofits with energy efficient technologies
- Develop a database with case studies of promising energy saving technologies and measures (current, proven, well known in some countries or underused somewhere else)
- Identify tools/computer programs to screen selected candidate technologies/ measures, develop a procedure for that and screen for representative conditions
- Summarize by categories results of the screening analyses and the case studies and present in a user-friendly format.
- The database of measures and technologies will be used in subtask D

Subtask C: Develop "Best-Practice Guidelines for Innovative Energy Performance Contracts"

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- Analyze and summarize EPC best practice agreements and financial options and their applicability in different country environments
- Compare technical/engineering practices in the areas of baseline development, estimation of energy and cost savings, risks and guarantees, and measurement and verification of savings
- Develop Best-Practice Guidelines

Subtask D: Develop IT-Toolkit "EnERGo"

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IT Tool-kit "EnERGo" based on the Energy Concept Adviser (ECA) will allow users to obtain extensive information, according to their individual focus of interest:

- **Areas of energy saving opportunities (Subtask A)**
- **Design inspirations and advice (increased number of the energy efficient technologies and measures from Subtask B)**
- **Benchmark tools**
- **Implementation decision tools with tailored recommendations on pratical implementation from Subtask C**

Annex 46 Deliverables

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- **Energy Assessment Guide for Energy Managers and ESCOs**
- **Screening procedure and retrofit data base with results of the technical and economic analysis**
- **Best-Practice Guidelines for Innovative Energy Performance Contracts**
- **IT-Toolkit “EnERGo”**

Participants

Country	Organization	Contribution
Canada	Public Works	Subtasks A,B,D
Denmark	Cenergia	Subtasks A,B,C,D
	SBI	Subtasks A,D
	Int. Center for Indoor Environment and Energy	Subtask B
Finland	Technical Research Centre of Finland/VTT	Subtasks A, B,C,D
Germany	Fraunhofer Institute of Building Physics	Subtask B,C,D
	Ennovatis, GmbH	Subtask A,C,D
	Schiller Engineering	Subtask A
Italy	Politechnico Milano	Subtask B,D
Poland	FEWE	Subtasks A,,B(Obsr), D
Russia	ABOK	Subtask B, D (Obsr)
	CRIIB	Subtasks A, B,D(Obsr)
	CENEF	Subtasks A, B, D
Slovakia	Slovak University of Technology	Subtasks B,D
UK	University of Strathclyde / Energy Systs Res. Unit (ESRU)	Subtasks B,D
USA	US Army Corps of Engineers, ERDC	Subtasks A,B,C,D
	US Army Corps of Engineers	Subtasks A,B,C
	NAVFAC	Subtasks A, B
	Oak Ridge National Laboratory	Subtasks C
	Oklahoma State University	Subtask B
	University of Illinois, Chicago	Subtasks A,B
	Johnson Controls, Inc.	Subtask B
	Plymovent Corp	Subtask B

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USACE ERDC (USA) - Operating Agent
Finland – Subtask A leader
Denmark – Subtask B leader
ORNL (USA) – Subtask C leader
Fraunhofer Institute (Germany) – Subtask D leader

Annex 46 website

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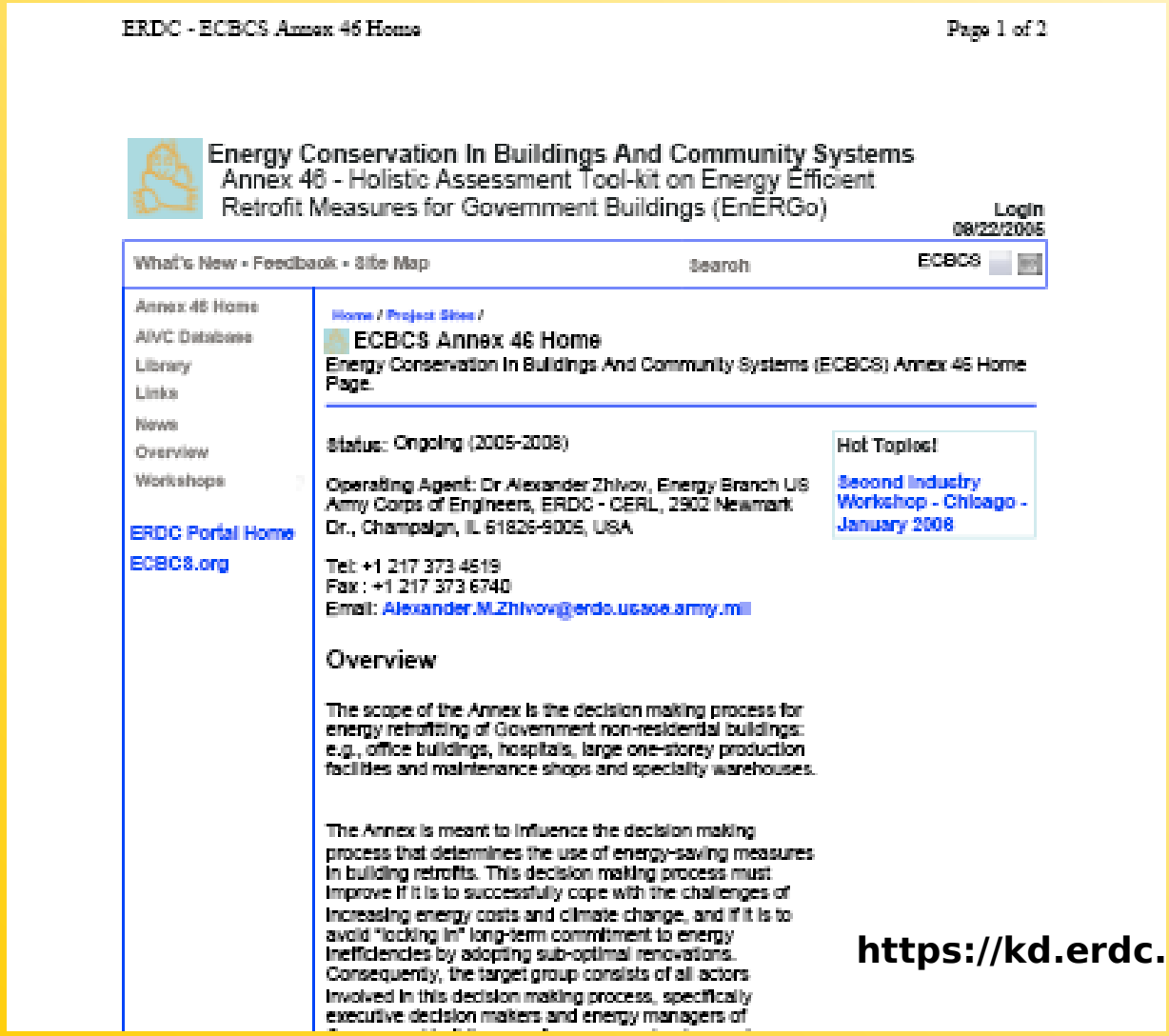

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Energy Conservation In Buildings And Community Systems
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Status: Ongoing (2005-2008)

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Hot Topics!

Second Industry Workshop - Chicago - January 2008

Overview

The scope of the Annex is the decision making process for energy retrofitting of Government non-residential buildings: e.g., office buildings, hospitals, large one-storey production facilities and maintenance shops and speciality warehouses.

The Annex is meant to influence the decision making process that determines the use of energy-saving measures in building retrofits. This decision making process must improve if it is to successfully cope with the challenges of increasing energy costs and climate change, and if it is to avoid "locking in" long-term commitment to energy inefficiencies by adopting sub-optimal renovations. Consequently, the target group consists of all actors involved in this decision making process, specifically executive decision makers and energy managers of

https://kd.erdc.usace.army.mil/projects/ecb

First Annex 46 planning meeting and workshop “Energy Efficiency in Government Buildings” Orlando (USA) February 4-6, 2005

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70 participants from 8

- **Shared information and ideas in a collegial forum**
- **Provided technical and methodological support to energy managers, designers, and Energy Saving Companies**
- **Provided a forum to prepare the detailed Program of Work, select subtasks leaders and distribute tasks for the IEA ECBCS Annex 46 “Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo)**

Second Annex 46 planning meeting “Energy Efficiency in Government Buildings” Berlin (Germany) May 23-25,

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- Developed the detailed work plan for each four subtasks of the Annex
- Identified new participating countries/ organizations and their contributions to Subtasks
- Identified first preliminary steps in execution of Subtasks
- Collected information from the technical tour of retrofitted buildings in Berlin

Third Annex 46 planning meeting and Seminar “Energy Efficiency in Government Buildings” Helsinki, (Finland) October 5-7, 2005

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- Finalized the work plan and milestones for each four Subtasks
- Identified time budget and specific contributions from participating countries/ organizations
- Presented and discussed preliminary results
- Finalized the Annex presentation
- Collected information from the technical tours of retrofitted buildings

Second Workshop and Annex 46 Experts meeting Chicago, IL (USA) January 19-22, 2006

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- Co-sponsored by DOD, DOE and ASHRAE
- Participants 90+ energy managers, contractors, researchers, manufacturers, and decision makers from the government sector from 12 countries.
- The Workshop agenda includes 37 presentations addressing:
  - National and International Energy Conservation in Buildings Programs, Directives and Guidelines
  - Presentation of selected results of completed IEA ECBCS Program Annexes and first deliverables resulted from the Annex 46
  - Energy Conservation Technologies and Measures for new buildings and building retrofits

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Back-up slides for Subtask B

ECMs for office buildings and baracks/dormitories

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- Replace windows non-operable (VLT 0.5-0.7, neutral color glazing, SHGC > 1.55)
- Replace windows with operable and similar characteristics as in (1)
- Based on (2), use hybrid ventilation (mechanical in hot and cold seasons, natural - during mild seasons)
- Cool roofs – new and re-roofing projects
- Insulate roofs while conducting re-roofing project
- Solar walls.
- Replace entrance doors with a better insulated and sealed
- Install vestibules
- Install windbreakers when vestibule is impossible]
- Insulate attic
- Ventilate attic
- Exterior window shading (light shelves)
- Exterior window shading (vertical fins)
- Exterior window shading (planting trees)
- Skylights (Solar tubes)
- Night pre-cooling
- Dimming controls for daylight harvesting
- Reduce duct leakage
- Insulate supply and return ducts
- Roof spray cooling
- Insulate hot/cold water pipes

Current list of ECMs for office buildings and barracks/dormitories, cont.

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- Separate ventilation system and AC system (DOAS and similar)
- Replace window AC with a central air system
- Replace window AC with a DX split system
- Exhaust heat recovery with an enthalpy wheel
- Exhaust heat recovery with a heat pipe
- Direct evaporative cooling
- Indirect evaporative cooling
- Hydronic heating/cooling with radiant panels
- Hydronic heating with convectors
- Demand control CO2 sensors
- Replace existing lights with T8 and instant start ballasts
- Add task lighting
- Install occupancy sensors
- Install floor heating (hydronic or electric)
- Thermal energy ice storage
- Thermal energy cold water storage
- Replace steam/hot water AHU heaters for indirect gas-fired heaters
- Replace motors with a premium efficiency motors
- Re-arrange systems to create zones (e.g., perimeter and core, by facade)
- HVAC weekend setback temperature

Temperature on the Surfaces of Absorbing Roofs (OAT = 34°C)

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Cool and Standard Brown Metal Roofs

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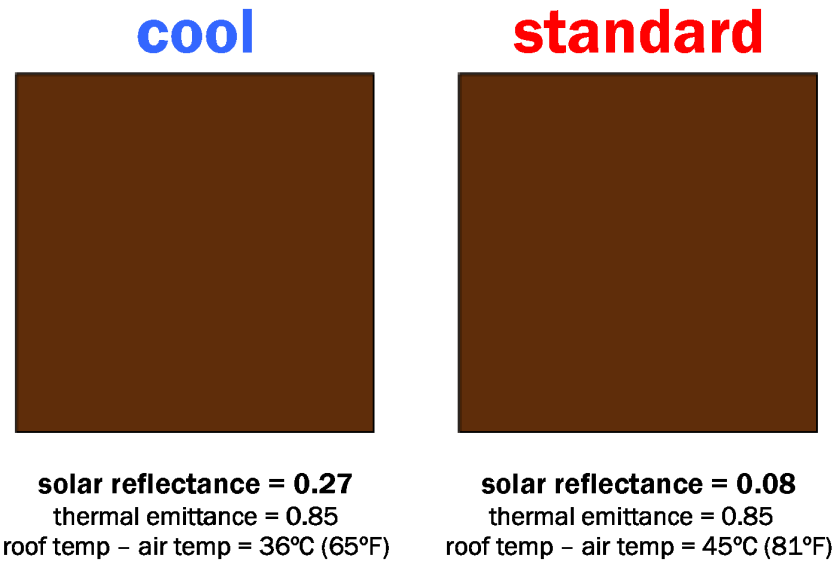
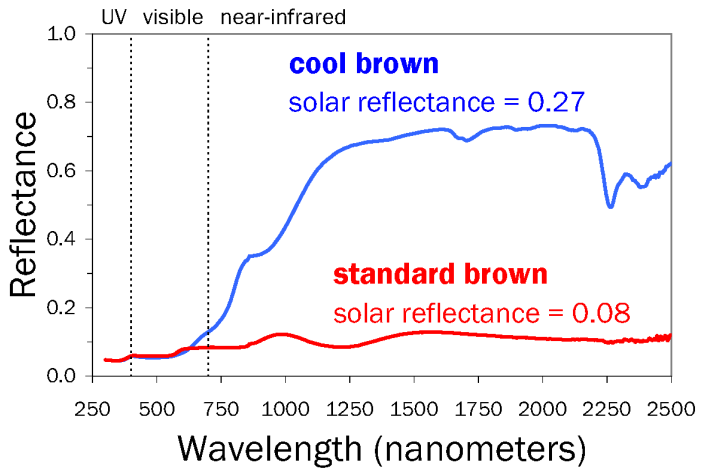
Cool brown 9ºC cooler than standard brown

brown metal panel

COURTESY BASF CORPORATION


cool
standard
solar reflectance = 0.27
thermal emittance = 0.85
roof temp – air temp = 36ºC (65ºF)
solar reflectance = 0.08
thermal emittance = 0.85
roof temp – air temp = 45ºC (81ºF)



Solar Wall

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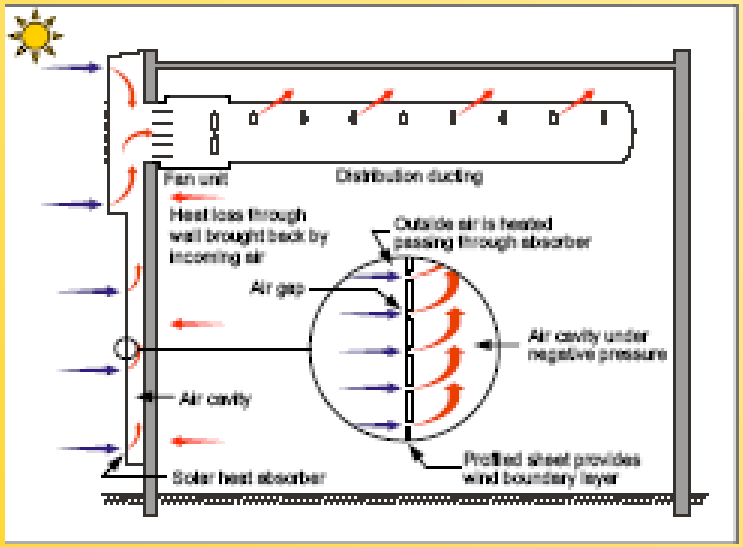
Fan unit
Distribution ducting
Heat loss through wall brought back by incoming air
Outside air is heated passing through absorber
Air gap
Air cavity under negative pressure
Air cavity
Profiled sheet provides wind boundary layer
Solar heat absorber

A transpired solar collector to preheat make-up air

Ft Carson hangar first Fed facility with solar wall (FY96)

$140K retrofit cost

$11K/yr gas savings

Current List of Industrial ECMs

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HVAC

- **Use displacement ventilation/temperature stratification on shops with excessive heat in summer**
- **Use de-stratification fans or high velocity nozzles in winter**
- **Use recirculating air in summer to reduce cooling loads**
- **Replace forced-air/steam air heating units with radiant gas heaters**
- **Use DEC(a), IDEC (b) and DEC/IDEC(c) for cooling plant air in summer**
- **Use natural gas heating to replace steam/hot water heating in central AHU**
- **Enclose process/optimize existing hood design for optimal performance (airflow rate)**
- **Solar wall for outdoor air preheating**

BUILDING ENVELOPE

- **Replace roofs using “cool roof” technology**
- **Vestibules for large opening**
- **High-speed roller doors for large openings**
- **Reduce leaks through the building envelope**

Current List of Industrial ECMs,cont.

SUPPORT SYSTEMS

- **LIGHTING**
  - **Install task/spot lighting at work places**
  - **Install lighting tubes**
  - **Replace high-intensity discharge lamps with high-intensity fluorescent lamps**
  - **Replace incandescent lamps with compact fluorescent lamps (CFLs)**
  - **Replace incandescent or fluorescent exit lamps with light emitting diodes (LEDs)**
  - **Use natural lighting**
- **MOTORS/ELECTRICAL SYSTEMS**
  - **Replace motors with a premium efficiency motors**
  - **Replace belts with a high efficiency belts**
  - **Use properly sized motors for applications**
  - **Replace old lightly loaded transformers**
- **COMPRESSED AIR**
  - **Compressed air management program**
  - **Compressed air leak management program**
  - **Reduce compressed air system pressure**
  - **Reduce inappropriate uses of compressed air**
  - **Air compressor heat recovery**

Industrial ECMs

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MANUFACTURING ENERGY CONSERVATION

MAINTENANCE/REPAIR SHOPS

- **Install close capture vehicle exhaust for moving/stationary vehicles**

METAL CASTING

- **Install static frequency converters on the induction furnaces**
- **Install Acutrak electric melting system for aluminum and nonferrous metals**
- **Replace switchgear system with advanced insulated gate bipolar transistor (IGBT) converters**
- **Adopt molten metal blanketing (MMB)**

METAL FINISHING

- **Insulate high temperature plating tanks**
- **Install covers on chromium plating tanks**
- **Use plating fixtures allowing for reduction of plating time and labor for parts masking**

PAINTING

- **Utilize infrared/UV paint curing (HVAC)**
- **Reduce air flow in paint booth by using VFDs**
- **Energy recovery in paint booths (HVAC)**

Industrial ECMs

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MANUFACTURING ENERGY CONSERVATION

- **HEAT TREAT**
  - **Heat recovery from air exhausted from heat-treatment ovens**
  - **Adopt atmospheric plasma microwave heat treating**
  - **Adopt ausforming as a heat treat and grinding procedure**
  - **Incorporate a heat-treating planning system for batch furnaces**
- **WELDING**
  - **Demand based local exhaust system for welding shops (HVAC)**
  - **Reduce fumes/ventilation air with GMAW or FCAW pulse welding**
  - **Reduce fumes/ventilation air with Low-Fume Welding Cored Wires**
  - **Reduce fumes/ventilation air by suing shield gas with low C02 content**

Industrial ECMs

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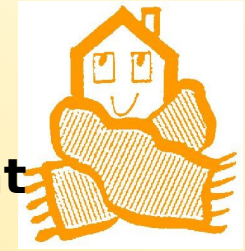

CONTROLS

- **Install VFD drives to balance HVAC system with a flexible production (number of production equipment pieces and exhausted airflow changes) (HVAC)**
- **Use setback thermostats**
- **Turn-off equipment when not in use (no idling motors, etc.) (Motors, Compressed air, all processes)**
- **Optimize AHU running time vs. occupancy time**
- **Balance ventilation and production shops (per 1,000 cfm of infiltrating air)**

Industrial Facilities Heating

Unit Hot Water Heaters

Radiant Heaters

Portable Gasoline Fired Heaters

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Plating Tank Cover

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Some Energy Conservation Measures for a Weld

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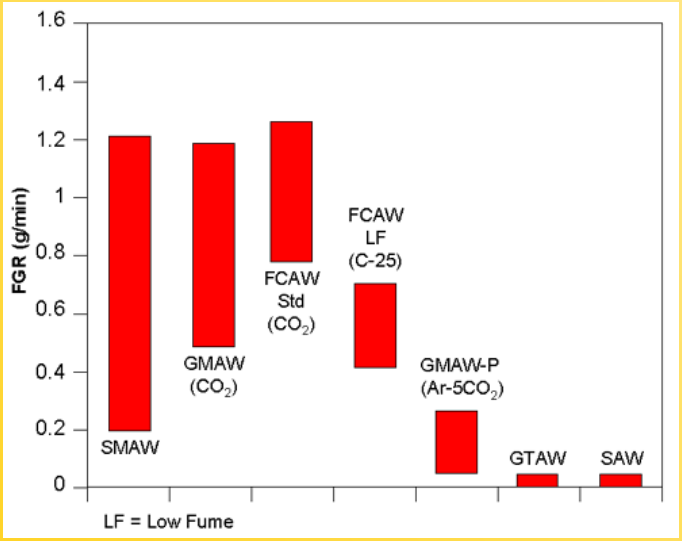
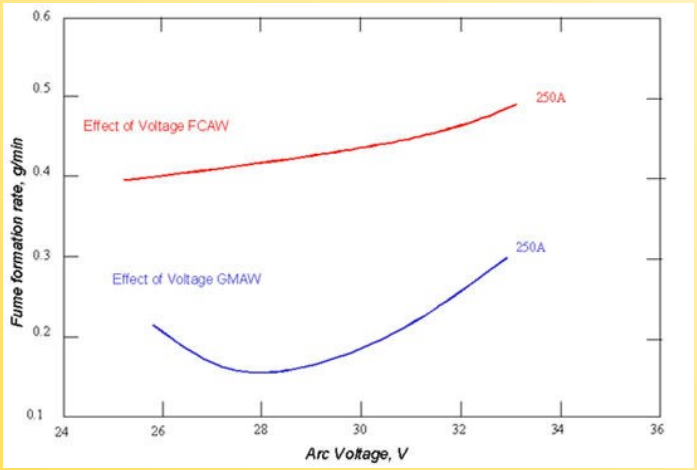
Weld Process Selection

Optimize Voltage





Optimize Shielding Gas

- 100% CO_2
- 75% Ar-25% CO_2
- 90% Ar-10% O_2
- 95% Ar-5% CO_2
- 98% Ar-2% O_2

Increasing Oxidizing Potential

Increasing Fume

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Contact Information

https://kd.erdc.usace.army.mil/projects/ecbcs

http://www.ecbcs.org/annexes/annex46.htm

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Thank you